Claims

1. A material comprising ribbons, fibrils or fibres characterised in that each of the ribbons, fibrils or fibres have an antiparallel arrangement of peptides in a β- sheet tape-like substructure.

2. A material according to claim 1 characterised in that the peptide is selected from the group P11-1, P11-2, P11-3, P11-4, P11-5, P11-6 and P10-7.

3. A material according to claim 1 characterised in that the material comprises a self assembling peptide (SAP) wherein the SAP forms a tape in an aqueous medium and is made up of 3 or more polar/neutral amino acids and a plurality of charged amino acids.

4. A material according to claim 3 characterised in that the ratio of polar/neutral amino acids to charged amino acids is from 11:1 to 11:3.

5. A material according to claim 3 characterised in that the polar/neutral amino acids, which may be the same or different, and are selected from the group including glutamine, serine, asparagine, glutamic acid, orthinine, cysteine, lycine, histidine and threonine.

6. A material according to claim 3 characterised in that the amino acids are positively charged and form a gel at a pH of less than or equal to a neutral pH.

7. A material according to claim 3 characterised in that the amino acids are negatively charged and form a gel at a pH of greater than or equal to a neutral pH.

8. A material according to claim 3 characterised in that the SAP is P11-1.

9. A material according to claim 3 characterised in that the amino acid chain is extended to include a bioactive peptide sequence.

10. A material according to claim 3 characterised in that the amino acid chain is attached to a therapeutically active molecule.

11. A material according to claim 1 characterised in that the material comprises an SAP which forms ribbons and/or fibrils in an aqueous solution and wherein the SAP has a primary structure in which at least 50% of the amino acids comprise an alternating structure of polar and apolar amino acids.

12. A material according to claim 11 characterised in that the polar amino acids include from 1 to 3 net charged amino acids per 11 amino acids.

13. A material according to claim 12 characterised in that the SAP is selected from the group P11-2, P11-3, P11-4 and P11-5.

14. A material according to claim 11 characterised in that the material is suitable for treatment in tissue engineering.

15. A material according to claim 11 characterised in that the material is suitable for use in cell culture medium.

16. A material according to claim 11 characterised in that the material is suitable for use in dental treatment.

17. A material according to claim 11 characterised in that the material comprises a self assembling peptide (SAP) wherein the SAP forms a tape in an aqueous medium and is made up of 3 or more polar/neutral amino acids and a plurality of charged amino acids.

18. A material according to claim 11 characterised in that the polar/neutral amino acids, which may be the same or different, and are selected from the group including

glutamine, serine, asparagine, orthinine, cysteine, lycine, histidine, glutamic acid and threonine.

19. A material according to claim 11 characterised in that the apolar amino acids, which may be the same or different, and are selected from the group including phenylalanine, tryptophan, valine, leucine, isoleucine and methionine.

20. A material according to claim 17 characterised in that the amino acid chain is extended to include a bioactive peptide sequence.

21. A material according to claim 18 characterised in that the amino acid chain is attached to a therapeutically active molecule.

22. A material according to claim 1 characterised in that the SAP is P11-3.

23. A material according to claim 1 characterised in that the SAP is soluble in a highly ionic medium.

24. A material according to claim 23 characterised in that the SAP comprises a ratio of net charged amino acids to total amino acids of from 1:11 to 4:11.

25. A material according to claim 23 characterised in that the material is suitable for treatment in tissue engineering.

26. A material according to claim 23 characterised in that the material is suitable for use in cell culture medium.

27. A material according to claim 23 characterised in that the material is suitable for use in dental treatment.

28. A material according to claim 1 characterised in that the tapes are alternating peptide or complementary peptide tapes.

29. A material according to claim 28 characterised in that the complementary peptide tapes are made up of 3 or more polar amino acids of which some are charged amino acids wherein the ratio of charged amino acids to total amino acids is 3:11 or greater.

30. A material according to claim 29 characterised in that the SAP is selected from the group P11-6 and P10-7.

31. A material according to claim 28 characterised in that the amino acid chain is extended to include a bioactive peptide sequence.

32. A material according to claim 28 characterised in that the amino acid chain is attached to a therapeutically active molecule.

33. A material according to claim 28 characterised in that the material is suitable for treatment in tissue engineering.

34. A material according to claim 28 characterised in that the material is suitable for use in cell culture medium.

35. A material according to claim 28 characterised in that the material is suitable for use in dental treatment.

36. A material according to claim 1 characterised in that the persistence length of the ribbons, fibrils or fibres is from 20nm - 70 μm.

37. A material according to claim 36 characterised in that the peptide is a P11-3 variant.

38. A material according to claim 1 characterised in that the material substantially comprises ribbons.

39. A material according to claim 1 characterised in that the material substantially comprises fibrils.

40. A material according to claim 1 characterised in that the material substantially comprises fibres.

41. A material according to claim 39 characterised in that the fibrils are comprised in a network of fibrils interconnected at fibre-like junctions.

42. A material according to claim 1 characterised in that a solution of the material has a nematic transition occurring at $C_{I/N} = 0.9$ mM.

43. A material according to claims 39 or 40 characterised in that the fibrils or fibres are in the form of a nematic fluid.

44. A material according to claim 43 characterised in that the nematic fluid is an elastomeric gel.

45. A material according to claim 1 characterised in that the material is in the form of a tissue engineering scaffold.

46. A material according to claim 45 characterised in that the scaffold is seeded with cells.

47. A material according to claim 47 characterised in that the cells may be ligamentum cells for growing new ligaments, tenocytes for growing new tendon, chondrocytes for cartilage, osteoblasts for bone, cardiac cells for cardiac tissue

engineering, stromal cells for tissue patches, fibroblasts and keratinocytes for skin and mesenchymal stem cells for any of these applications.

48. A material according to claim 1 characterised in that the material possess one or more of the features selected from high tensile strength at low weight, high modulus, high chemical resistance, high toughness, high cut resistance, low elongation to break, low thermal shrinkage, high dimensional stability and flame resistant and self extinguishing.

49. A material according to claim 1 characterised in that the processed fibres possess characteristics selected from the following: continuous filament yarn, high tensile strength, processable on conventional looms, twisters, cord forming, stranding and serving equipment; staple, very high cut resistance, spun on conventional cotton or worsted spinning equipment, precision cut short fibres, processable on felting and spun lace equipment; pulp-wet and dry, floc, precision cut short fibres, high surface area, miscible in blend composites, thermal resistance, excellent friction and wear resistance; cord, high tensile strength and modulus at low specific weight, retention of physical properties at high and low temperature extremes, very low heat shrinkage, very low creep, good fatigue resistance; fabric, excellent ballistic performance at low weights; and excellent resistance to cuts and protrusion combined with comfortable wear and excellent friction and wear performance against other materials.

50. A material according to claim 1 characterised in that the material comprises a skin treatment.

51. A material according to claim 50 characterised in that the skin treatment comprises skincare and dermatological applications for cosmetic and/or medical treatment.

52. A material according to claim 50 characterised in that the skin treatment comprises one or more of skin protection, improvement in skin feel, improvement of

skin strength, increased suppleness, delivery of active or beneficial substances, moisturisation, improved appearance and/or anti-ageing effects.

53. A material according to claim 1 characterised in that the material comprises a hair care product.

54. A material according to claim 53 characterised in that the that the hair care product comprises a hair care to improve hair condition, strength, feel, suppleness, appearance and/or moisturisation.

55. A material according to claim 54 characterised in that the that the hair care product comprises a hair shampoo, conditioner, dye, gel, mousse and/or other dressing.

56. A material according to claim 1 characterised in that the material comprises a network adapted for the delivery of perfumes, vitamins and/or other beneficial agents to the skin and/ or hair.

57. A material according to claim 56 characterised in that pH responsiveness is used to control the delivery process.

58. A material according to claim 1 characterised in that the material is sterilised.

59. A material according to claim 58 characterised in that the material is sterilised by gamma irradiation.

60. A material according to claim 59 characterised in that the material is sterilised as a dry powder.

61. A method of tissue engineering which comprises the use of a SAP as a scaffold.

62. A method of tissue engineering according to claim 61 which comprises seeding a scaffold according to claim 45 with appropriate cells.

63. A method of tissue engineering according to claim 61 which comprises bone repair.

64. A method of tissue engineering according to claim 61 wherein the method comprises the prevention, treatment and/or alleviation of dental caries.

65. A method of tissue engineering according to claim 64 wherein the method comprises the mineralisation or remineralisation of a dental cavity.

66. A method of tissue engineering according to claim 64 wherein the method comprises suppression of demineralisation.

67. A method of tissue engineering according to claim 64 wherein the SAP is used as a preventive coating for a tooth surface.

68. A method of tissue engineering according to claims 65-67 wherein SAP is the P11-3 peptide.

69. A method of sterilising a material according to claim 1 which comprises gamma irradiation of a dry powder of the material.

70. The use of a material according to claim 45 in the manufacture of a tissue repair scaffold.

71. The use of a material according to claim 1 in the modification of the wetting properties or anti-icing properties of a material, for controlling the interaction of oil/water with clay surfaces, the stabilising of clay itself or dealing with fractures in oil-wells.

72. The use of a material according to claim 1 in the manufacture of materials for use as sensors, as biocatalysts, or as separation media in biotechnology applications.

73. The use of a material according to claim 1 in the manufacture of bioresponsive and biocompatible surfaces produced by adhesion, spreading and growth of endothelial cells in medical implant materials.

74. The use of a material according to claim 1 in the manufacture of artificial skin.

75. The use of a material according to claim 1 in the manufacture of systems adapted to provide paths/tracks, to control and guide the direction of growth or movement of molecules or cells.

76. The use of a material according to claim 1 as a template for the nucleation and growth of inorganic materials.

77. The use of a material according to claim 1 in the manufacture of materials with applications in biomedical fields such as in tissue engineering, wound healing and tissue adhesion.

78. The use of a material according to claim 1 in the manufacture of systems adapted for protection of teeth and/or for nucleation of hydroxyapatite.

79. The use of a material according to claim 1 in the manufacture of skin treatment products.

80. The use of a material according to claim 1 in the manufacture of a material with the features selected from one or more of high tensile strength at low weight, high modulus, high chemical resistance, high toughness, high cut resistance, low

elongation to break, low electrical conductivity, low thermal shrinkage, high dimensional stability, flame resistant and self extinguishing.

81. The use of a material according to claim 1 in the manufacture of a material selected from one or more of the following forms, continuous filament yarns, staple, floc, cord and fabric.

82. The use of a material according to claim 1 in the manufacture of a continuous filament yarn with properties selected from, high tensile strength and processable on conventional looms, twisters, cord forming, stranding and serving equipment.

83. The use of a material according to claim 1 in the manufacture of a staple with properties selected from, very high cut resistance, capable of being spun on conventional cotton or worsted spinning equipment, and precision cut short fibres, processable on felting and spun lace equipment.

84. The use of a material according to claim 1 in the manufacture of a wet or dry pulp or floc, with properties selected from, precision cut short fibres, high surface area, miscible in blend composites, thermal resistance friction resistance and wear resistance.

85. The use of a material according to claim 1 in the manufacture of a cord, with properties selected from, high tensile strength and modulus at low specific weight, retention of physical properties at high and low temperature extremes, very low heat shrinkage, very low creep, good fatigue resistance, and excellent ballistic performance at low weights.

86. The use of a material according to claim 1 in the manufacture of a fabric with properties selected from, excellent friction and wear performance against other materials and excellent resistance to cuts and protrusion combined with comfortable wear.

87. The use of a material according to claim 1 in the manufacture of a material with applications selected from adhesives, and sealants, e.g. thixotropes; in ballistics and defence, e.g. anti-mine boots, gloves – cut resistance police and military, composite helmets, and vests – bullet and fragmentation; in belts and hoses, e.g. automotive heating/cooling systems, automotive and industrial hoses, and automotive and industrial synchronous and power transmission belts; in composites, e.g. aircraft structural body parts and cabin panels, boats, and sporting goods; in fibre optic and electro-mechanical cables, e.g. communication and data transmission cables, ignition wires, and submarine, aerostat and robotic tethers; in friction products and gaskets, e.g. asbestos replacement, automotive and industrial gaskets for high pressure and high temperature environments, brake pads, and clutch linings; in protective apparel, e.g. boots, chain saw chaps, cut resistant industrial gloves, helmets – fireman and consumer (bicycle), and thermal and cut protective aprons, sleeves, etc; in tires, e.g. aircraft, automobiles, off-road, race, and trucks; and in ropes and cables, e.g. antennae guy wires, fish line, industrial and marine utility ropes, lifting slings, mooring and emergency tow lines, netting and webbing, and pull tapes.

88. The use of a material according to claim 1 in the manufacture of a material characterised in that the material comprises a skin treatment.

89. The use of a material according to claim 88 in the manufacture of a material characterised in that the skin treatment comprises skincare and dermatological applications for cosmetic and/or medical treatment.

90. The use of a material according to claim 88 in the manufacture of a material characterised in that the skin treatment comprises one or more of skin protection, improvement in skin feel, improvement of skin strength, increased suppleness, delivery of active or beneficial substances, moisturisation, improved appearance and/or anti-ageing effects.

91. The use of a material according to claim 1 in the manufacture of a material characterised in that the material comprises a hair care product.

92. The use of a material according to claim 91 in the manufacture of a material characterised in that the that the hair care product comprises a hair care to improve hair condition, strength, feel, suppleness, appearance and/or moisturisation.

93. The use of a material according to claim 92 in the manufacture of a material characterised in that the that the hair care product comprises a hair shampoo, conditioner, dye, gel, mousse and/or other dressing.

94. The use of a material according to claim 1 in the manufacture of a material characterised in that the material comprises a network adapted for the delivery of perfumes, vitamins and/or other beneficial agents to the skin and/ or hair.

95. The use of a material according to claim 94 in the manufacture of a material characterised in that pH responsiveness is used to control the delivery process.

96. A scaffold constructed using a combination of material according to claim 1 and other existing commercial and/or naturally occurring polymers.

97. A scaffold according to claim 96 for use in tissue engineering.

98. A scaffold according to claim 96 for use in wound healing.

99. A peptide network substantially as described with reference to the accompanying examples.